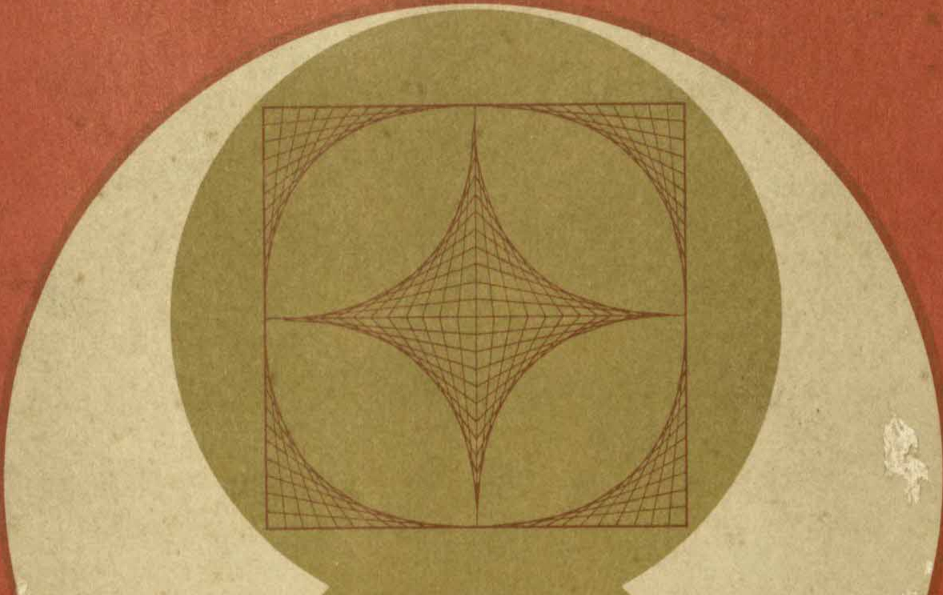
Cyril Harries

A/381

The Geometry of the Point and Line



DISCOVERY PROGRAMMES

The Geometry of the Point and Line

This programme has the following test record:
First tested in four schools in four localities
Error rate on all frames = 7%
Further tested with 40 children in four schools
(three Junior, one Secondary)
Error rate on all frames = 3·5%
Error rate on published programme with representative population = 2·5%
Parallel test to Test 2, given three weeks later,
revealed a retention figure of 56%

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81-1636

~~4710~~

STATE INSTITUTE OF EDUCATION
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DISCOVERY PROGRAMMES
General Editor: John Leedham, M.Ed.

The geometry of the point and line

Cyril Harries

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Illustrated by Kay Young

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Titles in this series will include

THE AIR WE BREATHE by John Leedham
A FIRST BOOK OF SETS } by John Clarke
A SECOND BOOK OF SETS } by John Clarke
THE SCARLET RUNNER by John Fieldhouse
AREA AND VOLUME by John Leedham and D. V. Parker

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Introducing Discovery Programmes

Discovery Programmes are programmed books developed by practising teachers. They seek to introduce fresh material, or to put forward traditional material in a new way; they are intended to be a real adjunct to the work of the teacher. All have been carefully tested and have proved their worth under classroom conditions. The texts require a reading age of 10·4 or above; no previous knowledge of their subjects is needed.

Discovery Programmes are the fruit of experiments in programmed learning carried out by a group of teachers in the Leicestershire Education Authority. Our programmes were tested and re-tested in many schools in the locality, and the editor would like to express his appreciation of the help provided by the Director and Committee of the Leicestershire Education Authority.

"Programmed Learning is one of the most important new tools teachers have at their disposal. We are only at the beginning of exploring its full potential and I certainly will not attempt to guess how far it will take us. The important thing is to realise that it is a tool to be used by the teacher and not a substitute for him. A programme has the merit of infinite patience and it gives its undivided attention to the child who is using it. If it is a good one, it is subtle in providing the right doses of motivation."

Stewart C. Mason, M.A.
Director of Education, Leicestershire

To the Teacher

This programme is devised for the top classes of the junior school and the first year of the secondary school. A reading age of 10 years 4 months or more is required. It is assumed that the pupil is able to measure feet and inches.

Contents:

- The point—size, position, set of points and shape; space
- The line—straight and curved
- Types of line—horizontal, vertical, oblique and parallel
- Measurement of lines—lengths between points, dimension; sign and direction
- Curved lines—convex, concave, compound

Materials required for practical work:

- Magnifying glass
- Lengths of string
- Nut or bolt, or similar weight
- Piece of strawboard, 12″ × 12″
- Ruler
- Sheet of paper
- Water container (glass or bottle)
- Spirit level
- Cane

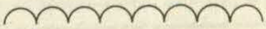
The work of the actual programme is estimated at five hours; other work will take additional time. The pupil will need a piece of paper as wide and as long as this page to cover the answers while he works the frames. Frames 1, 6 and 11 explain how the correct answer is obtained.

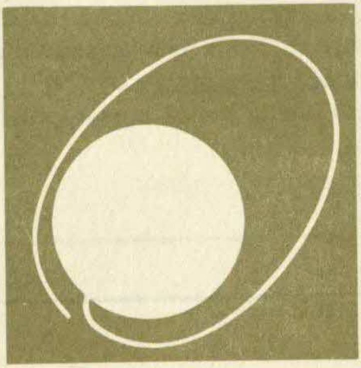
At the conclusion of the programme, the pupil will be able to: define the position and size of points; relate point to line and line to space; perform practical work with all types of straight lines.

To the Pupil

You will all have read about people known as astronauts who have flown into space. Before an astronaut can leave the ground, scientists have to work out how to build the rocket that will take him into space, what fuel to use to fire the rocket, what metals to make it from, and what track or path it should take.

Let us imagine that we are travelling without a rocket to one of the stars. Because of the great distance that we have to go, we shall need many resting points on the way. So if we plotted our journey, it would look something like this:

earth  star



But a rocket would cover the points so quickly that its path would be very smooth. In this picture you can see a rocket's path traced by a line around the earth (this line is called an orbit). One day you may go into orbit, and you should know something about space before you go.

Your rocket will cover the gaps between the resting points so quickly that we shall be able to say: "The path of that moving point (your rocket) traced a line." The part of mathematics which deals with points and lines is called GEOMETRY, and teaches us many interesting things about space and shape.

To the Pupil

This is a programme. This is how it works:

1 Cut a piece of cardboard or paper just long enough and wide enough to cover this page from top to bottom and side to side, including the coloured margin.
This we call a *mask*.
Place it over the frame below this one.
Now write down in your notebook the answer to this question.
Is the coloured margin on the right—
1½ miles wide? 1½ inches wide?
To find out if you are right, pull down the mask until you can just see the answer printed in the margin.

---

2 Mark your answer. Your answer should always be written down before you check it.
This is because we LE – – N better if we try on our own.
Write down the word.
Move down the mask.

1
1½ INCHES

---

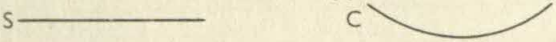
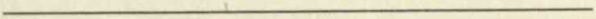
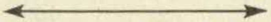
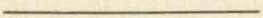
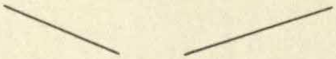
3 Check your answer.
Now you know how to use the programme.

2
LEARN

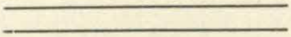
Pre-test

If you score 25 or more on this pre-test, you do not need this programme.

1	Geometry deals with space. Of what is space made up?	
2	In geometry, these ...... have a special use. What is it?	1 POINTS
3	What is the geometrical name for these ...... ?	2 TO REPRESENT A POINT
4	This · stands for something in space. What is it?	3 DOTS
5	How is a line made up?	4 POSITION
6	In moving from A to B we make a t – – – –.	5 OF A SET OF POINTS
7	What is a line?	6 TRACE
8	What is a straight line?	7 THE TRACE OF A MOVING POINT
9	What is a curved line?	8 THE SHORTEST DISTANCE BETWEEN TWO POINTS
10	A line has one dimension. What is it?	9 A LINE WHICH CHANGES ITS DIRECTION FROM A TO B

11	How is direction shown in geometry?	10 LENGTH
12	Give names to these two types of line: 	11 BY ARROWS
13	Give another way of writing inches (as a sign).	12 STRAIGHT CURVED
14	Careful and exact work is a------e work.	13 ″
15	If you guess the length of this line you only e------- its length. 	14 ACCURATE
16	A line is said to have no t--------.	15 ESTIMATE
17	Lines can be drawn in different directions and also in many p--------.	16 THICKNESS
18	What else does geometry teach us about besides space?	17 POSITIONS
19	The d-------- of this line does not change. It is straight. 	18 SHAPE
20	This line is straight and also h---------. 	19 DIRECTION
21	This line is also straight, but it is drawn in a v------- position.	20 HORIZONTAL
22	These lines are straight, but they are neither upright nor level. They are o------. 	21 VERTICAL

23 These lines are said to be p – – – – – – – to each other.

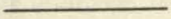


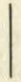
24 What tool would a builder use to check if his work were upright?

25 What tool would he use to check if his work were level?

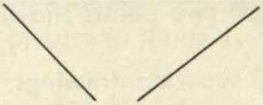
26 What can you use to draw a straight line?

27 Anything with a s – – – – – – – e – – – can be used to draw a line.

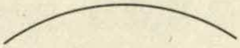
28 What other name can be given to this line? 

29 What other name can be given to this line? 

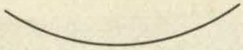
30 What can these lines also be called?



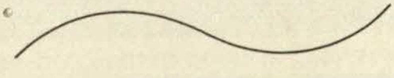
31 This curved line is called a c – – – – – curve.



32 This curved line is called a c – – – – – – curve.



33 This curved line is called a c – – – – – – – curve.



22 OBLIQUE

23 PARALLEL

24 PLUMB-LINE OR PLUMB-BOB

25 SPIRIT LEVEL

26 RULER

27 STRAIGHT EDGE

28 FLAT LEVEL

29 UPRIGHT

30 SLANTING SLOPING

31 CONVEX

32 CONCAVE

33 COMPOUND

Experiments to be carried out before work on the programme begins

The only material needed is a length of string.

1 Draw the lines made by the string when it is in these positions:

lying flat on your desk edge and pulled tightly.
tied round one end of a pencil and allowed to hang from your hand to the floor.
stretched from one corner of your desk to the other and pulled tightly.

2 Draw as carefully as you can the exercise book you are using, in an open position.

3 Tie knots in your string at a number of different places. Draw the string as it appears to you when pulled tightly.

4 Here are two points showing the positions of A and B.

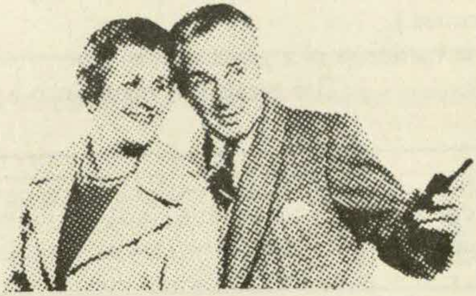
A · · B

Make 3 separate drawings.

a Join A to B with the shape of path you think a snake would make.
b Join A to B with the shape an aeroplane makes in looping the loop.
c Join A to B with the shape a rope makes when it is pulled tightly between A and B.

Before you read and answer any question, be sure that the next frames are covered by your mask

1 Examine this newspaper picture. The picture is made up of a great number of dots.



Complete this sentence:

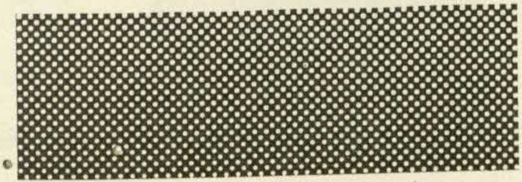
This picture is made up of a great number of – – – –.

ANSWER

2 Use a magnifying glass to examine the picture in frame 1 more carefully.
Would it be possible to count the dots under the glass?
Yes or no?

1
DOTS

3 The magnifying glass enlarges the size of the dots so that they can be counted.
This can be done because each dot is separated.



The dots can be counted because they are s – – – – – – – – .

2
YES

4 Each dot is separated by a gap or space. Between each dot there is a – – – or – – – – –.

3
SEPARATED

5 The picture is made to fit into a shape, suitable for the paper. Dots appear as lines to make a final shape.
The complete picture in frame I is put into a – – – – –.

4
GAP
SPACE

6 Fill in the missing letters, making words to complete this sentence. (This frame uses words which you have already learnt in the first 5 frames.)
A newspaper picture is made up of a great number of – – – –, separated by s – – – – –. The picture is made into a suitable s – – – –.

5
SHAPE

7 The part of mathematics which deals with shape and space is called GEOMETRY.
Name one part of mathematics.

6
DOTS
SPACES
SHAPE

8 In geometry, dots are used for a special purpose. They are used to "stand for" POINTS. Dots stand for – – – – – –.

7
GEOMETRY

9 In mathematics another word is used instead of "stand for". This word is REPRESENT. A dot is used to – – – – – – – – – a point.

8
POINTS

10 A point is represented in geometry by a – – –.

9
REPRESENT

11 This frame uses words learnt in frames 7 to 10. Fill in the missing words and complete this sentence.

In g – – – – – – – a – – – is used to r – – – – – – – – a – – – – –.

10
DOT

12 All the dots in this example are of different sizes.

A ● B • C ● D ● E .

Dot A is (small/big). Dot E is (big/small).
Which of the words in the brackets is correct?

11
GEOMETRY
DOT
REPRESENT
POINT

---

13 In frame 12, each dot represented a p – – – –.

12
DOT A = BIG
DOT E = SMALL

---

14 What sharp metal object could be used to make a very small point?

13
POINT

---

15 Draw a number of dots of different sizes, using a pencil, pin, or anything else you wish. Put them in many POSITIONS and give them letters. Each of these dots is in a certain p – – – – – – –.

14
PIN OR NEEDLE

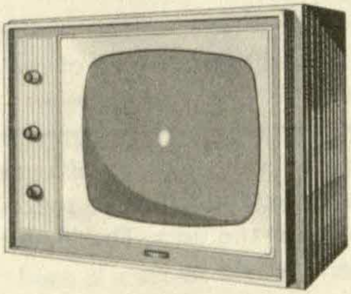
---

16 The position of each dot was named by using a l – – – – –.

15
POSITION

---

17 This is a picture of a television set which has just been turned off. The spot in the centre of the screen is quite big to start with. This spot shrinks and shrinks until it disappears. The spot quickly changes its s – z –.



The spot does *not* change its pos – – – – –.

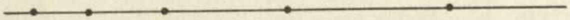
16
LETTER

18 The spot shrinks down to a very, very small p – – – –.

17
SIZE
POSITION

---

19 Copy the line shown below, with the five dots on it. Draw five snowballs which get larger and larger until the last becomes a snowman. In your own drawing, make sure that your snowballs just touch the dots on the line.



18
POINT

---

20 In the last examples, the size of the dots was not important. Each dot was drawn in a p – – – – – – – –.

19

---

21 Because a dot represents a point, we can say that a p – – – – has position.

20
POSITION

---

22 It can now be written that:
A – – – represents the position of a point.

21
POINT

---

23 From our examples, we can see that a point is represented by a dot of any size.
The smaller we can draw a dot, the nearer it is to a true point.
A true point has no s – – –.

22
DOT

---

24 Write down this definition in your book:
A point has position but no size. The point is represented by a dot.

23
SIZE

---

25 A true point is shown by a (big/small) dot. Which of the words in the bracket is correct?

---

26 We said that the picture in frame I was made up of a great number of dots. In a picture taking up much more space it would be impossible for us to count the dots. The bigger the space, the more impossible it would be.
Space is made up of a countless n – – – – – of points.

25
SMALL

27 In the small space magnified in the picture in frame 3, it is possible to count the dots. Would it be possible to count all the points represented by dots in a space as big as your house?
Yes or no?

26
NUMBER

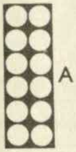
---

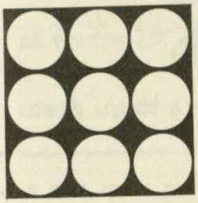
28 Space is a c – – – – – – – – – number of p – – – – –

27
NO

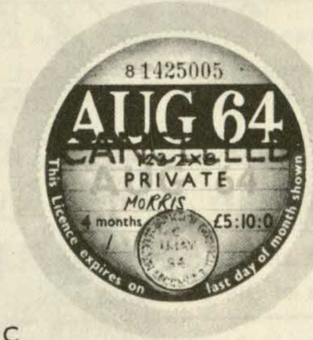
---

29 In these examples there are dots of different s – z – –
Example A shows dots seen under a magnifying glass. (The dots are part of the picture in frame 3.)


A


B

Example B shows dots enlarged many thousands of times their actual size.
In example C, the points or perforations are cut round the licence.



C

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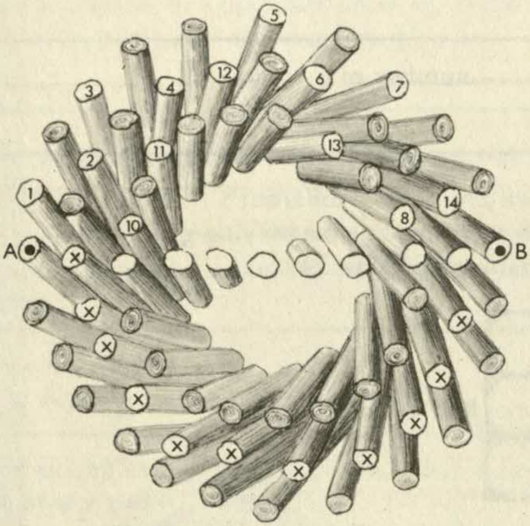
In modern mathematics, these dots are called a SET OF POINTS
Now complete these sentences. Count the number of points you can see.
In example A there is a set of – – points.
In example B there is a set of – points.

28
COUNTLESS
POINTS

30 Look hard at examples A and B in frame 29.
How does each row appear to you?
Each row of points appears like a l – – e.

31



Four flies went for a walk; they all started at A and finished at B.
The first used the points marked 1 to 8 and home.
The second used the points marked 10 to 14 and home.
The third used all the points marked X and home.
The fourth took the quickest way possible from A to B.
Draw the shape of the path each took.

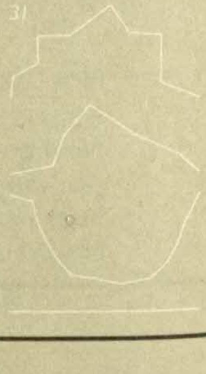
---

32 In making the path, 1 covered a set of – – points;
2 covered a set of – points;
3 covered a set of – – points;
4 covered a set of – – points.
(Include A and B.)

29
SIZES
12
9

30
LINE

31



33 The name given to this path is TRACE.
A path is a t – – – –.

32
10 7
13 11

---

34 The trace of the movement from point A to point B is called a line.
The trace of a moving point is called a – – – –.

33
TRACE

---

35 The pencil point or ball point you used to follow the paths of the flies drew a – – – –.

34
LINE

---

36 Write this definition in your book (complete the gaps).
The t – – – – of a moving p – – – – is called a l – – –.

35
LINE

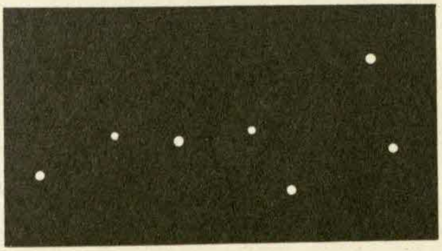
---

37 Look again at frame 29. You can see now that any line is a set of points.
Any line is made up of a – – – of – – – – – –.

36
TRACE
POINT
LINE

---

38 Astronomers are men or women who study the heavens. Many years ago they suggested that imaginary lines should be used to make CONSTELLATIONS of stars. Some constellations were given names, such as The Plough, The Little Bear, Hercules, and very many others.
Here are the positions of the stars which form The Plough.



Copy the drawing of the constellation into your book. Join up the stars. Look for pictures of other constellations in books which you have at school.

37
SET
POINTS

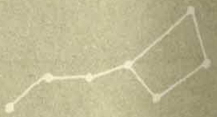
39 The stars which are used to pick out the shapes of these con – – – – – – – – – – – – act as points in the sky.

This picture shows the sky with the stars that you can see at night. Many are too far away to be seen by the naked eye, but they are there all the same.

The stars in the heavens can be called p – – – – –.

40 Space is made up of a c – – – – – – – – – number of p – – – – –.

38



39
CONSTELLATIONS
POINTS

40
COUNTLESS
POINTS

Test 1

Answer these questions on a separate clean sheet of paper. The answers are on the last page. Turn to them only after the whole test has been finished.

1 This part of mathematics is called g – – – – – – –.
2 A newspaper picture is made up of d – – –.
3 The picture in frame 38, representing the stars, is made up of dots and is formed into a s – – – –.
4 What does a dot stand for?
5 What word is used instead of "stand for"?
6 A true point is said to have no s – – – –.
7 A dot represents the p – – – – – – – of a point.
8 These are called a s – – of p – – – – –.
9 The movement or path of a point from A to B is called a t – – – –.
10 The trace of a moving point is called a – – – –.

---

41 In frame 31 you traced the path of 4 flies. The direction taken by each fly was different. Which one covered the most ground and which one covered the least ground?
Fly (1, 2, 3, or 4) covered most ground.
Fly (1, 2, 3, or 4) covered least ground.

42 The fourth fly went in a direct line from A to B. The other 3 flies changed their directions. Which of the lines made the shortest trace?
The shortest trace was number (1, 2, 3, or 4).

43 The direct line is the sh – – – – – – line.

44 The name given to this direct line is STRAIGHT.
A direct line is a s – – – – – – – line.

41
1 = MOST
4 = LEAST

42
4

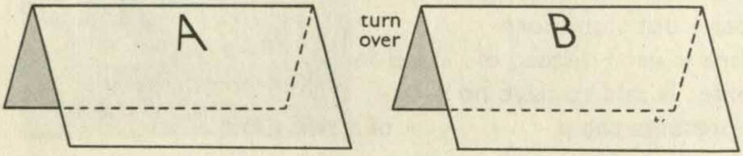
43
SHORTEST

45 Write this definition in your book (complete the gaps).
The sh – – – – – – distance between two points is called a s – – – – – – – line.

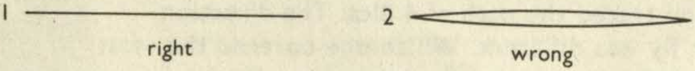
44
STRAIGHT

---

46 To draw a straight line it is necessary to have a straight edge.
Find a small piece of paper and fold it with a sharp crease. Mark one side A and the other B.



With A uppermost, draw a line along the edge.
With B uppermost, draw a line along the edge.
If the two lines are on top of each other, as in 1 below, your crease has made a straight edge. If your two lines look like 2 below, your edge is not straight and you must try again. Keep your straight edge for checking other edges, and for drawing straight l – – – –.



45
SHORTEST
STRAIGHT

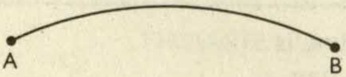
---

47 In frame 31, the trace of the fourth fly was a straight line because it did not change its direction. The other 3 traces were not straight lines because the flies changed their d – – – – – – – – –.

46
LINES

---

48 A line which changes its direction in going from point A to point B is called a curved line.
This line changed its direction in moving from point A to point B and is called a c – – – – – line.



47
DIRECTIONS

49 Write these definitions in your book (complete the gaps). A line of any shape is made up of a s– – of p– – – – –. If the trace between two points is the shortest possible distance between them, it is a– – – – – – – – line. If the – – – – – – – – – of the line changes, it is a – – – – – – line.

48
CURVED

---

50 A point has position but no s – z –.

49
SET
POINTS
STRAIGHT
DIRECTION
CURVED

---

51 Because any line is made up of a set of points which have no size, a true line is said to have NO THICKNESS.
A true line has no t– – – – – – – –.

50
SIZE

---

52 A point has p– – – – – – – but no size.

51
THICKNESS

---

53 A set of points in the shape of a line must also have p– – – – – – –.

52
POSITION

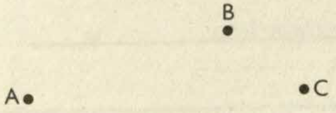
---

54 A true line has p– – – – – – – but no t– – – – – – – – –.

53
POSITION

---

55 Draw 3 points and letter them as shown.



54
POSITION
THICKNESS

---

56 Join A to B with a straight line. Use your paper straight edge to draw the line.
Join B to C with a curved line.
Join C to A with a curve of a different shape.

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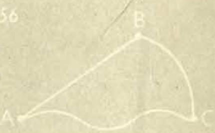
57 An instrument we can use in school to draw a straight line is called a RULER.
The ruler is called an i – – – – – – – – – –.

56



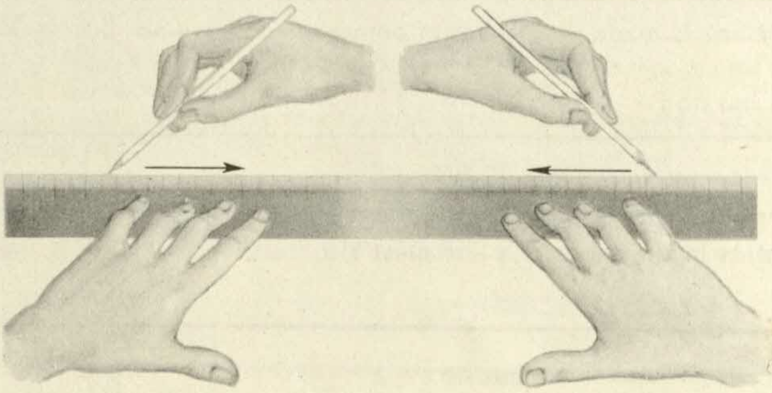
---

58 There are many other objects which have straight edges. Your exercise book is an example. You are writing and drawing lines with something that has a straight edge.

57
INSTRUMENT

---

59 This diagram shows you the correct way to use your ruler. Paper edges, the ruler, and the pencil all have st – – – – – – e– – – –



right handed

left handed

---

60 A straight edge draws an accurate straight line.
The line drawn by a straight edge is a – – – – – – – –.

59
STRAIGHT
EDGES

---

61 An accurate line is one which is drawn carefully and exactly.
When work is accurately done it is c – – – – – – – and e – – – –.

60
ACCURATE

---

62 If the instrument you use has a good straight edge, it can be used to draw an a – – – – – – – – line.

61
CAREFUL
EXACT

63 The ruler is one in – – – – – – – – – we can use to draw a straight line.

62
ACCURATE

---

64 Using your paper straight edge, draw your exercise book in an open position. Make as accurate a drawing as possible. This means being c – – – – – – and e – – – –.

63
INSTRUMENT

---

65 It is assumed that you are able to measure with your ruler. Most rulers have 12 inches marked on them. (Others have 6 inches or perhaps 9 inches.)
How many $\frac{1}{2}$-inches are there on a 12-inch ruler?
How many $\frac{1}{4}$-inches are there on a 12-inch ruler?

64
CAREFUL
EXACT

---

66 The last frame used the complete word inches. There is no need to use this always, because there is a sign that can be used instead.
We write 1 inch, or 1in., or 1″.
We write 2 inches, or 2 in., or 2″.
Give two other ways of writing 6 inches.

65
24
48

---

67 What sign is used to represent inches?

66
6 in. or 6″

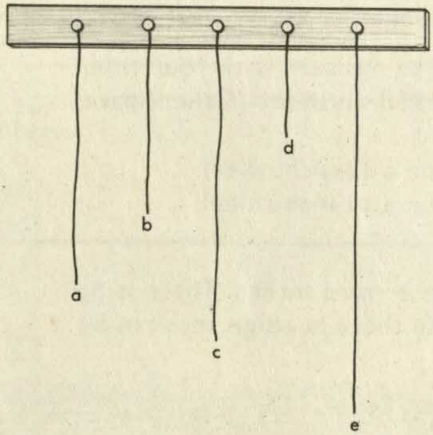
---

68 An important exercise in measuring is called ESTIMATING. This means that you are making a guess at the answer.
When we guess we e – – – – – – – –.
Frame 69 is an exercise in e – – – – – – ing.

67
″

69 As an exercise in estimating, cut 5 pieces of string, any length. Hang them up with pins on a piece of card, or Sellotape them on to your chair. (If your teacher will allow you, it would be even better to hang them from the blackboard.)

Estimate the length of each piece of string.



Take down each piece of string in turn and measure it accurately.

Make a table like the one below and complete it when you have made all your measurements.

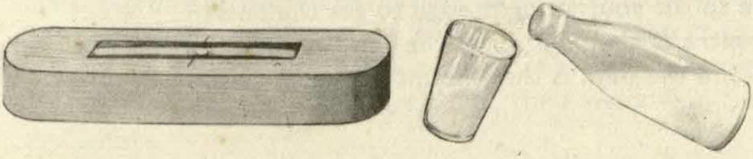
My estimate	Accurate length	Estimate		
		too much	too little	correct
a				
b				
c				
d				
e				

Extend your table and estimate the lengths of doors, windows, books, or any other things you can find.

70 Try this experiment. Find a clear glass or bottle and half fill it with water. Tilt the glass sideways. What do you notice? Repeat the experiment by tilting the glass in a number of different ways. Notice what happens in each case and record your observations (what you see) in drawings.

71 This is a picture of how the sky appears to join the sea.
The line appears to be a str– – – – – l– – –.
The line in this picture appears flat and level.

72 This is a picture of the instrument used by a craftsman when he wishes to check that his work is level. It is called a SPIRIT LEVEL. When the bubble can be seen in the exact centre of the glass rod, it means that the work is level, or flat.

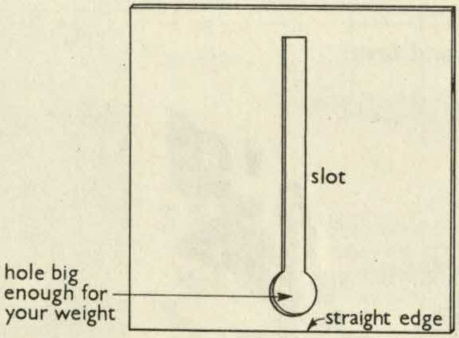


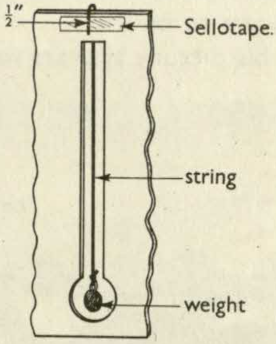
In the experiment with the glass or bottle of water (frame 70), the water always stayed level.

73 For this experiment you will need a string with a weight attached to it.

Ask your teacher if you may have a piece of thick card about a foot square.

Test that one surface edge is accurately straight by checking it with your paper straight edge. Next, cut out a shape similar to the one below.



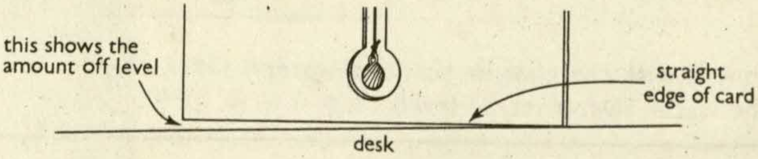


Hang the string in the centre of the slot with 1" of string hanging over the front. Sellotape the string firmly back and front at the top edge. Make sure that your weight is in the middle of the hole made for it.

This instrument is called a PLUMB-BOB.

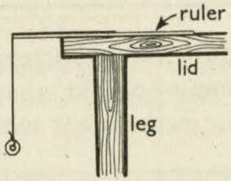
---

74 Place the straight edge of the card on your desk. If the bob hangs in the centre of the hole, your desk is level. You may have to tilt your straight edge to get the bob to hang in the centre of the hole. Then the gap between the straight edge and the desk is the amount that your desk is off level.



Vertical line experiment

As we learned earlier in this programme, a line can change its direction.
We can see that one kind of straight line is level, but there are lines that appear to hang down, or even to fall over.
This experiment explains the kind of line which seems to hang straight down.
Find a piece of string and something heavy, such as a nut or a bolt, to act as a weight. Tie your weight tightly to the end of the string.
Place your ruler over the end of the desk, and let the string with its weight hang down over the end of the ruler.
Wait for the string to stop moving. When it does, it is like a line hanging straight down.



When a weight hangs by a thread, the thread is always vertical.

Let the surface on which you place your ruler be anything but flat or level. Try the experiment again. The string still hangs straight down.

The name given to the string with the weight is PLUMB-BOB, or PLUMB-LINE.
This instrument is used by carpenters to make door-frames hang or stand upright, and by painters and decorators to make sure that the first piece of paper they hang is upright.
If craftsmen did not use a plumb-line, their work would be inaccurate.

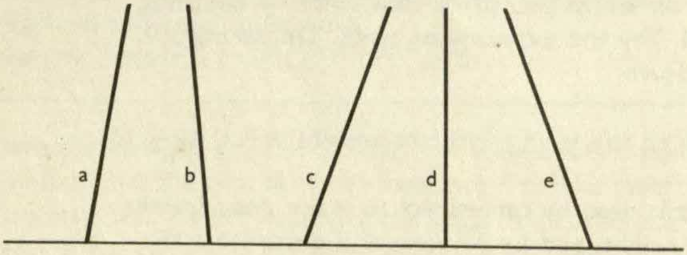
75 Name an instrument that can be used to find a level surface.

76 The line which appears to separate the sky or land from the sea in the picture in frame 71 is called the HORIZON.
In geometry, the name given to a flat or level line is HORIZONTAL.
A ---------- line is a flat or level line.

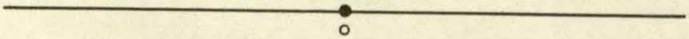
77 A horizontal line is always ---- or -----.

78 Draw 3 level lines. Under them write this sentence (complete the gap):
These are ---------- lines.

79 In this diagram there are lines drawn on a horizontal line. One of them appears as your plumb-bob did when you found the correct answer in your experiment with a level surface (frame 74).
Which line gave the correct answer—a, b, c, d, or e?



80 Draw as accurately as possible the line which gave the correct answer from the point O on this h --------- line.



75
SPIRIT LEVEL
PLUMB-BOB

76
HORIZONTAL

77
FLAT
LEVEL

78
HORIZONTAL

79
LINE d

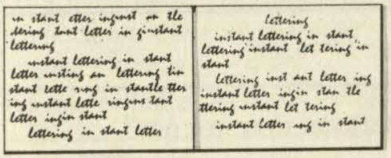
81 The line d is the correct line. It appears upright and the other lines appear to be falling over.
A line which is upright on a horizontal line is called a VERTICAL LINE.
An upright line is a v – – – – – – – – line.

---

82 A vertical line stands u – – – – – – – on a horizontal line.

---

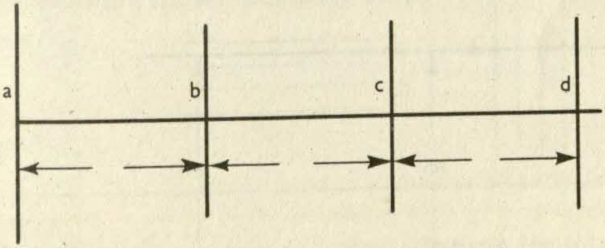
83 This is a drawing of your open exercise book. There are horizontal lines and also vertical lines in it.



Count the lines and complete this sentence:
There are 2 h – – – – – – – – – – – lines and 3 v – – – – – – – – lines in the drawing.

---

84 This diagram shows a TV aerial used in some parts of the country.



How many horizontal lines are there in it?
How many vertical lines are there?
Count each rod as a whole line.
Is the distance between each vertical rod the same or different?

80

HORIZONTAL

81
VERTICAL

82
UPRIGHT

83
2 HORIZONTAL
3 VERTICAL

85 Write down this definition.
A true vertical line is a line which, if produced (carried on), would pass through the centre of the earth.

84
1
4
THE SAME

---

86 Look for other examples of vertical lines.
Choose a very calm day and watch a spider hanging by its thread.
In your classroom, where there is no wind, let a ball drop from your hand a few times.
The spider's thread hangs, and the ball drops, v – – – – – – lly.

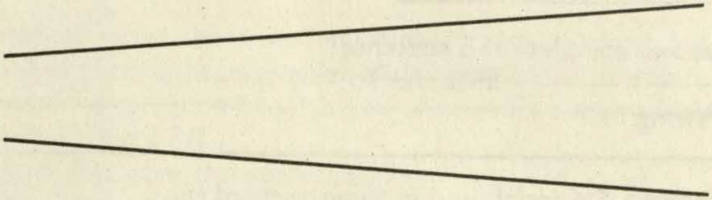
---

87 Lines which are vertical stand u – – – – – – –.

86
VERTICALLY

---

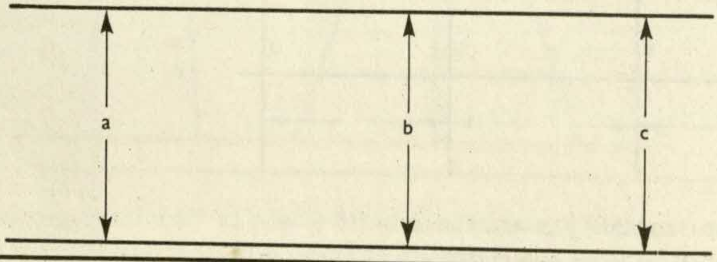
88 These lines are not horizontal because they are not l – – – –.



87
UPRIGHT

---

89 These lines are horizontal because they are f – – – or l – – – –.



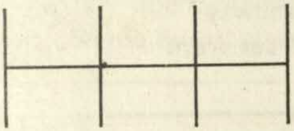
88
LEVEL

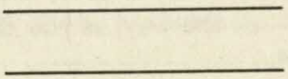
---

90 Measure the distance between the lines in frame 89 at positions a, b, and c.
Are the measurements at a, b, and c the same or different?

89
FLAT
LEVEL

91



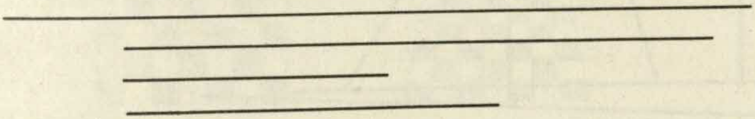


4 of the lines in diagram A are – – – – – – – –.
2 of the lines in diagram B are – – – – – – – – – – –.

90
THE SAME

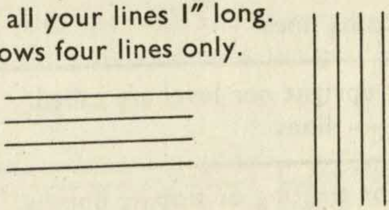
92 The answers to frames 84 and 89 showed that the distances between the lines being measured were the same. When lines have the same distance between them from end to end, they are called PARALLEL LINES.

These lines are called p – – – – – – – lines.



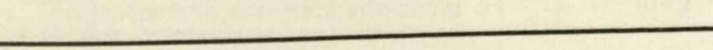
91
VERTICAL
HORIZONTAL

93 Draw ten vertical p – – – – – – – lines $\frac{1}{8}$″ apart. Next to them draw ten horizontal p – – – – – – – lines the same distance ($\frac{1}{8}$″) apart. Make all your lines 1″ long. The example shows four lines only.



92
PARALLEL

94 Is it possible for a train to travel non-stop from London to Edinburgh?



93
PARALLEL

95 The train could make the journey because the railway tracks are p – – – – – – – all the way, as you can see from the diagram in frame 94.

94
YES

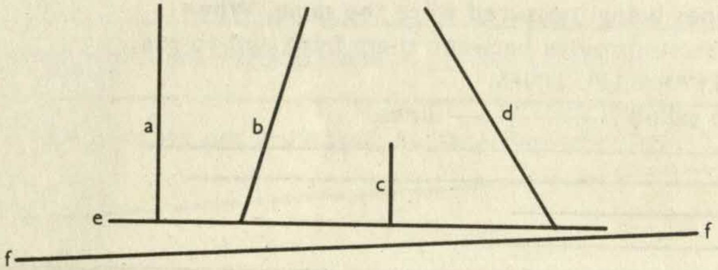
---

96 In your room there are numerous small objects that have parallel sides.
Draw three of them accurately in your book.

95
PARALLEL

---

97 In this diagram, there are some kinds of lines which we have not yet named. Which ones are they?



---

98 The lines b, d, and f do not stand up – – – – – –. Nor are they l – – – –.
They are slanting or sloping lines.

97
b d f

---

99 Lines which are neither upright nor level are called sl – – – – – – or sl – – – – – lines.

98
UPRIGHT
LEVEL

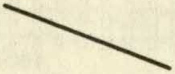
---

100 The geometrical name for slanting or sloping lines is OBLIQUE (pronounced *oh-bleak*) lines.
O – – – – – – lines are neither vertical nor horizontal.

99
SLANTING
SLOPING

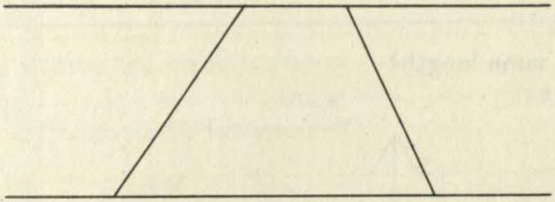
---

101 This straight line is an o – – – – – – line.



100
OBLIQUE

102 Draw two horizontal and parallel lines, 1″ apart. Draw two oblique lines between them, as shown in the diagram.



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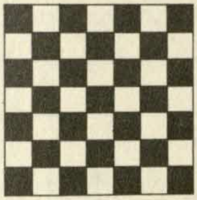
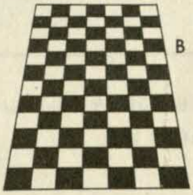
103 Oblique lines enable you to draw lines as they appear to your eye. Here are two examples.



A

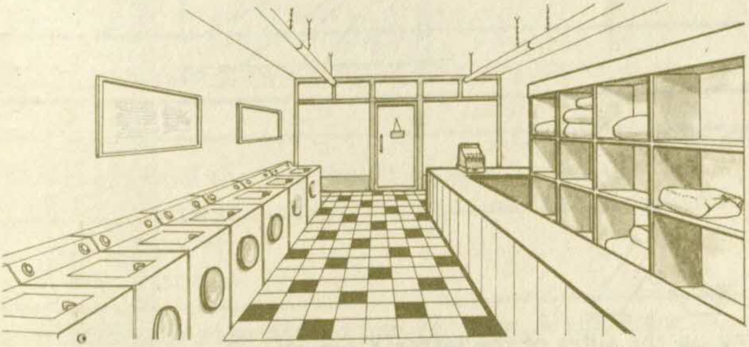


B

Example A is a tile pattern for a floor.
Example B is the pattern as seen from a distance.

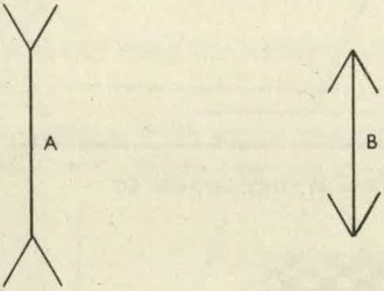
---

104 This shop is built with the walls and objects parallel. When we draw it using oblique lines, we get this effect.



The light strips and counters appear as o – – – – – – lines.

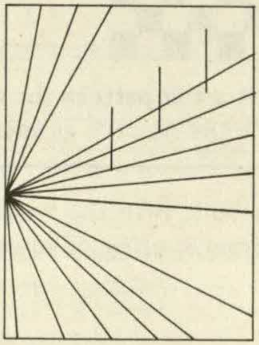
105 Which of the two vertical lines is the longer?
(To them are joined o – – – – – – lines.)
Is A the longer?
Is B the longer?
Are they both the same length?



104
OBLIQUE

---

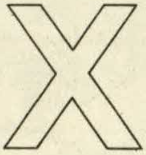
106 Copy this diagram as accurately as you can.
How many horizontal lines are there?
How many vertical lines are there?
How many oblique lines are there?



105
OBLIQUE
THEY ARE BOTH THE SAME LENGTH

---

107 This is a drawing of the letter X.



The lines making up the sides of the letter X are all o – – – – – –.

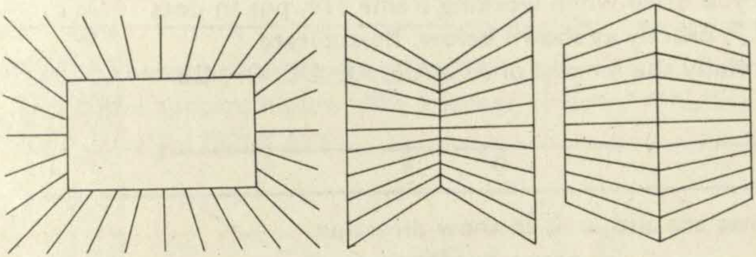
106
2 HORIZONTAL
5 VERTICAL
14 OBLIQUE

108 In the drawing in frame 107, the oblique lines making up the sides of the letter X are p------- to each other.
The horizontal lines are also p-------.

107
OBLIQUE

---

109 These patterns are made from h---------,
v-------, o------, and p------- lines.
Draw similar patterns for yourself.



108
PARALLEL
PARALLEL

---

110 Lines of all types are made up of a s-- -- ------.

109
HORIZONTAL
VERTICAL
OBLIQUE
PARALLEL

---

111 We have already written that a line has no th-------, because it is made up of a s-- -- ------ which have no size.

110
SET OF POINTS

---

112 Lines are also drawn in many different pos------.

111
THICKNESS
SET OF POINTS

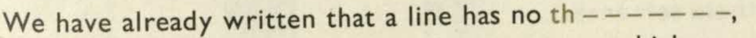
---

113 It is essential that we should be able to measure the distance between two points on a line. This distance is called LENGTH.
A line must have l-----.

112
POSITIONS

---

114 Across your page draw a line $3\frac{3}{4}''$ long. A and B are ----
representing the positions of the ------.

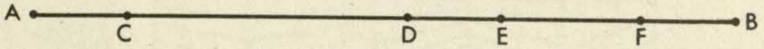


113
LENGTH

115 The true l – – – – – of the line is measured between the points A and B.
AB is the true l – – – – – of the line.

116 In mathematics length is called a DIMENSION.
The only d – – – – – – – – of a line is length.

117 On the line you drew when working frame 114, put in dots C, D, E and F, exactly as shown below. Be accurate.
Measure carefully the lengths of AC, AD, AE, DE, CF, CB and AB.



118 OBLIQUE lines are also used to show direction.
To show d – – – – – – – – arrow heads are used.

119 The directions of lines are shown by using – – – – –
– – – – –. ⟷
Draw a number of lines showing direction.

120 Complete these sentences.
The only d – m – – – – – – – of a line is l – – – – –.
The d – r – – – – – – – of a line is shown by a – – – – h – – – –.

121 The types of lines we have already dealt with have been straight lines. We said that a line which changed its direction when moving from point A to point B was called a c – – – – – line.

122 There are many kinds of curved lines.
For this experiment we shall need a cane. Hold the cane firmly at each end and press either upwards or downwards.
What have you done to the cane? You have b – – – it.

114
DOTS
POINTS

115
LENGTH
LENGTH

116
DIMENSION

117
½″ 2″
2½″ ½″
2¾″ 3¼″ 3¾″

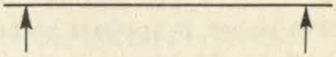
118
DIRECTION

119
ARROW HEADS

120
DIMENSION
LENGTH
DIRECTION
ARROW HEADS

121
CURVED

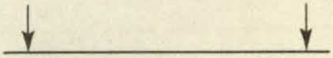
123 Draw the curve made when you pressed the ends of the cane upwards.



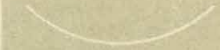
122
BENT

---

124 Draw the curve made when you pressed the ends of the cane downwards.



123



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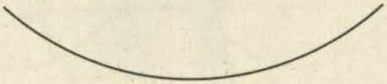
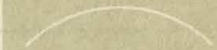
125 Each of these curved lines has a name.
This curve appears hollow, like a saucer or bowl. A hollow curve is called CONCAVE.



Draw some hollow curves. They are called c – – – – – –.

124



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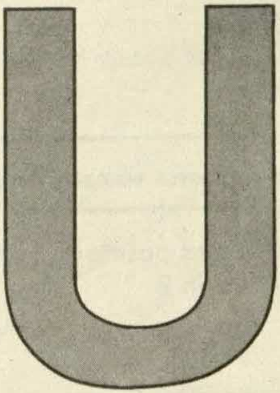
126 Look at the drawing of the letter U. What kind of a curve has U?



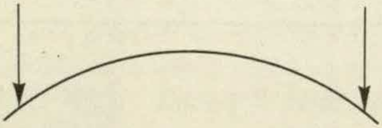
If this were a road, we could say it had a b – – – in it.

125
CONCAVE

127 When you bent the ends of the cane downwards this curve was made.

It is the opposite of a concave curve. It appears arched, and is rounded on the outside surface. An arched curve is called CONVEX.

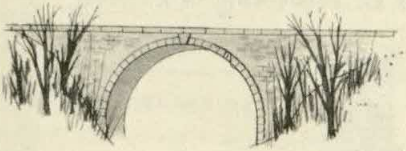
The top of your head has a c – – – – – shape.



126
CONCAVE
BEND

---

128 This bridge has a c – – – – – curve to it.



127
CONVEX

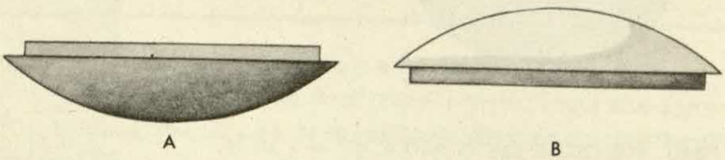
---

129 C – – – – – – and c – – – – – are opposite to each other.

128
CONVEX

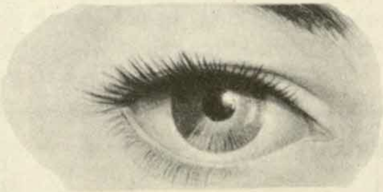
---

130 Here is a tin lid drawn in two different positions. Name the curve in position A and in position B.



129
CONCAVE
CONVEX

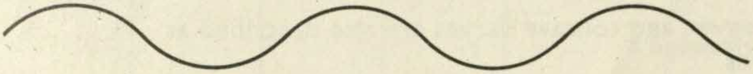
131 Here is a drawing of your eyelids.
The curved shape of the top lid is c – – – – –.
The curved shape of the bottom lid is c – – – – – –.



130
A CONCAVE
B CONVEX

---

132 Now join up both kinds of curve to make this shape.

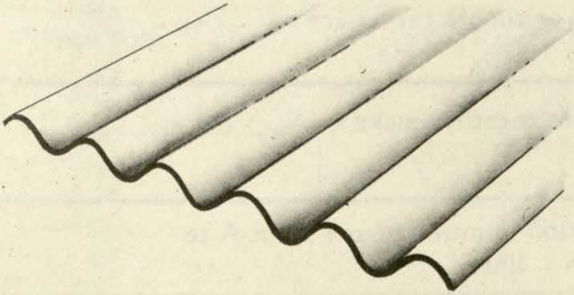


Draw a line like this in your book.
At the seaside you would call this a w – – –.
The line you have just drawn is a w – – y line.

131
CONVEX
CONCAVE

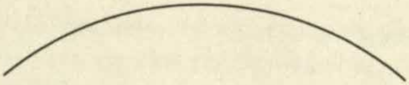
---

133 A wavy line appears like a convex and a concave curve joined together.
This sheet of corrugated plastic appears like a w – – – line.



132
WAVE
WAVY

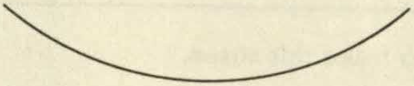
134 This convex curve is called a SIMPLE curve.



Another way of describing a convex curve is to call it a ------ curve.

133
WAVY

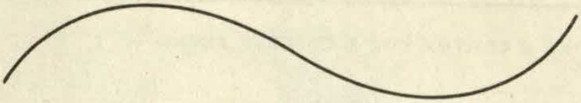
135 This concave curve is also a simple curve, but it can be called a PLAIN curve.



The simple convex and concave curves are also described as ----- curves.

134
SIMPLE

136 When two simple or plain curves are joined together to make a wavy line, we call the new curve a COMPOUND curve.



This is called a --------- curve.

135
PLAIN

137 Two names given to plain or simple curves are -------- and ------.

136
COMPOUND

138 Concave and convex curves together make a --------- curve.

137
CONCAVE
CONVEX

139 Lines which change direction in moving from point A to point B are called ------ lines.

138
COMPOUND

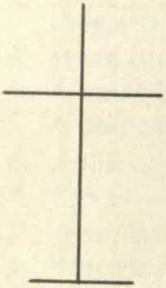
140 Lines which do not change direction in moving from point A to point B are called --------- lines.

139
CURVED

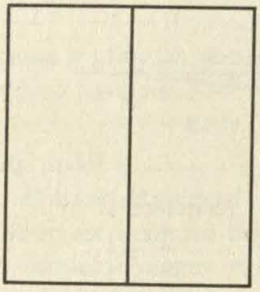
140
STRAIGHT

Patterns

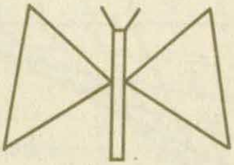
These patterns include all the lines learned so far. They are examples of straight lines, and are joined together to make shapes. Copy them, and draw some patterns of your own design.



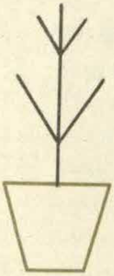
a cross



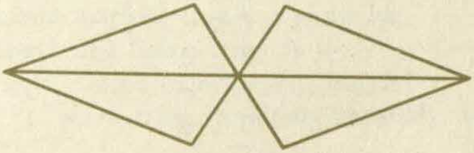
a pair of doors



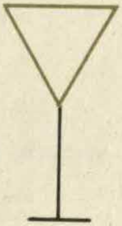
a butterfly



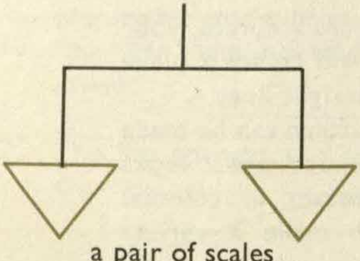
a flower pot



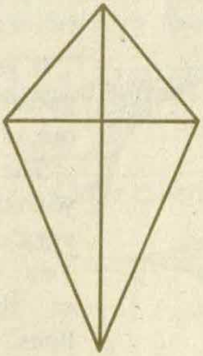
two arrow heads



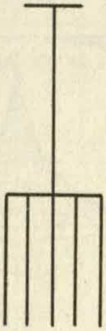
a wine glass



a pair of scales



a kite

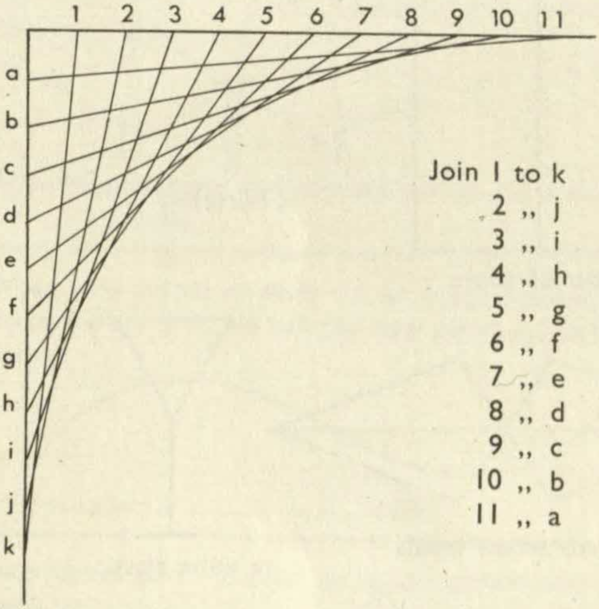


a garden fork

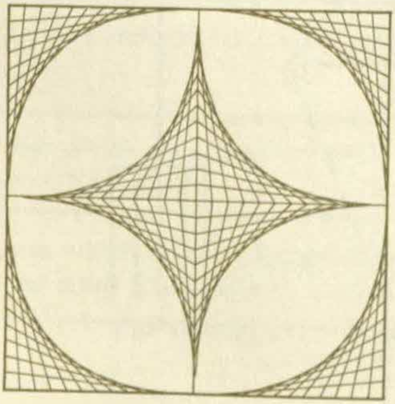
In this pattern, straight lines have been drawn and joined so that the result is a curve.

Try this for yourself. Follow the instructions carefully.

Draw two lines at any angle. Copy the drawing below if you like. Divide both lines into an equal number of parts. Your divisions could be every $\frac{1}{4}''$. Number one line and letter the other.



Join 1 to k
2 ,, j
3 ,, i
4 ,, h
5 ,, g
6 ,, f
7 ,, e
8 ,, d
9 ,, c
10 ,, b
11 ,, a



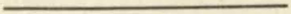
If you are accurate, your pattern will create a curve out of straight lines.

The pattern can be made with thread on card. It looks very pleasant in colours. You can make a variety of these patterns with lines drawn in different directions. The shape suggested opposite makes a very interesting pattern.

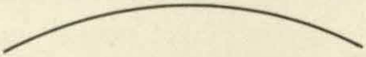
Test 2

This is a test on all the work done in this programme. Use a separate clean sheet of paper for your answers.

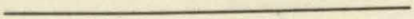
1 Space is made up of a countless number of ------.
2 The points in a very small space can be counted because they are s--------- from each other.
3 What represents a point in geometry?
4 A point is said to have no ----.
5 A point has p-------- only.
6 A line is made up of a --- -- ------.
7 The t---- of a moving point is called a ----.
8 What is the shortest distance between 2 points called?
9 What is a line which changes its direction called?
10 Because a point has no size, a line is said to have no ---------.
11 What are used to show the direction of a line?
12 The points marked on a line show its l-----.
13 The length of a line is its only d---------.
14 What sign is used to represent inches?
15 What is work that is done carefully and exactly called?
16 When we make a guess, we are e----------.
17 A line can be drawn in any p-------.
18 The set of points which can be seen in a newspaper picture are made into a s----.
19 This line does not change its direction. What is it called?



20 This line changes its direction and is called a s------ c----.

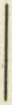


21• What is this line called?



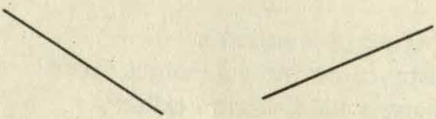
22 What other words mean the same as your answer to question 21?

23 What kind of line is this?



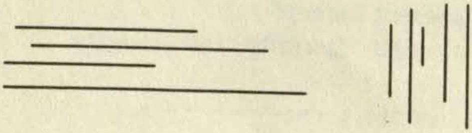
24 What other word can be used as your answer to question 23?

25 What are these lines called?

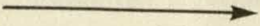


26 Give two other words that mean the same as your answer to question 25.

27 These lines are p -------- to each other.

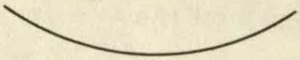


28 This line is showing d ---------.

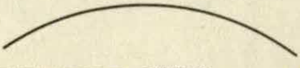


29 Name 2 instruments used by craftsmen to find a horizontal and a vertical line.

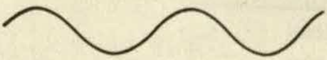
30 This is a c ------- curve.



31 This is a c ------ curve.



32 This is a c -------- curve.



ABCDEFG
HIJKLMN
OPQRST
UVWXYZ

Copy this example of the alphabet into your book. Make sure that you fill the width of each line, like this: AB

These exercises will give you plenty of practice in recognising the types of lines we have studied. If after doing an example or two you are sure that you can remember all about each line, then stop, but if not, carry on to the end.

Print the letters which have horizontal lines anywhere in them.

NOTE Letters like D, B, are *not* to be included as having horizontal lines in them.

Which letters have vertical lines?

A E F G H
L T Z

Which letters have oblique lines?	B D E F G H I J K L M N P R T U Y
Which letters have both horizontal and vertical lines?	A K M N R V W Y Z
Which letters have horizontal and oblique lines?	E F H L T
Which letters have vertical and oblique lines?	A Z
Is there a letter which includes all these lines?	K M N R Y
What kind of line have we missed out so far?	NO
Which letters are curved lines only?	CURVED
Which letters have horizontal, vertical, and curved lines?	C O Q S
Which letters have vertical and curved lines?	G ONLY
Which letters have oblique, curved and vertical lines?	B D G P R U
How many vertical lines are there in the word HORIZONTAL?	R ONLY
How many level or flat lines are there in the word HORIZONTAL?	8
How many oblique lines are there in the word HORIZONTAL?	8
What is the word starting with H that has in it 8 vertical lines, 6 horizontal lines, 5 oblique lines?	5

How many upright lines are there in the word VERTICAL?	HORIZONTAL
How many horizontal lines are there in the word VERTICAL?	5
How many oblique lines are there in the word VERTICAL?	6
What word starting with V has the following lines in it: 5 upright lines, 6 horizontal lines, 5 oblique lines?	5
How many vertical lines are there in the word OBLIQUE?	VERTICAL
How many horizontal lines are there in the word OBLIQUE?	6
How many sloping lines are there in the word OBLIQUE?	4
What word starting with O has the following lines in it: 6 vertical lines, 4 horizontal lines, no oblique lines?	NONE OR 0
How many horizontal lines are there in the word PARALLEL?	OBLIQUE
How many vertical lines are there in the word PARALLEL?	8
How many oblique lines are there in the word PARALLEL?	6
What word starting with P has the following lines in it: 8 horizontal lines, 6 vertical lines, 5 oblique lines?	5
HORIZONTAL VERTICAL OBLIQUE PARALLEL Which words have the most *completely curved letters?*	PARALLEL
	HORIZONTAL OBLIQUE

Answers to Test 1

1 Geometry
2 Dots
3 Shape
4 A point
5 Represent
6 Size
7 Position
8 Set of points
9 Trace
10 Line

Answers to Test 2

1 Points
2 Separated
3 A dot
4 Size
5 Position
6 Set of points
7 Trace; line
8 A straight line
9 A curved line
10 Thickness
11 Arrow heads
12 Length
13 Dimension
14 ″
15 Accurate
16 Estimating
17 Position
18 Shape
19 Straight line
20 Simple (or plain) curve
21 Horizontal
22 Flat; level
23 Vertical
24 Upright
25 Oblique
26 Slanting; sloping
27 Parallel
28 Direction
29 Plumb-bob or plumb-line; spirit level
30 Concave
31 Convex
32 Compound

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